AbstractID: 14558 Title: Uniform Scanning and Energy Stacking with Proton Beams

Patients have received treatments with proton beams using many different beam delivery techniques. The technique of uniform scanning with energy stacking has not often been discussed.

The first part of this course will provide an introduction to the technique including terminology. Topics to be covered include: scanning modes and patterns; history of electron and light ion scanning beam use in the clinic; energy stacking methods; energy/range considerations; and radiobiology of scanned beams. Advantages and disadvantages of the technique will also be discussed along with a brief review of scanning electron beam incidents to underscore the importance of safety in the use of the technique.

The second part of the course will provide a description of several potential hazards and some example mitigations for those hazards such as monitoring of the scanning magnet operation; monitoring of the delivered lateral fluence distribution; use of downstream MU detectors; MU rate checks; monitoring of the ratios of signals between MU detectors; and beam energy checks.

The third part of the course will provide some practical aspects for using the technique. Optimizing the scan pattern to obtain a laterally uniform dose distribution and sharp penumbra includes consideration of the density of scan lines and the beam overscan distance beyond the collimator edges. Optimization of the weights of the individual energy stack layers to obtain a uniform depth dose distribution over the target includes consideration of the width of the peak of the non-modulated depth dose distribution. Other parameters for which the user must be cognizant include the effective and virtual source distances for different magnet configurations and the minimum MU per layer which is a function of the MU rate and scanning frequency. The use of multi-element detectors to efficiently measure dose distributions in the depth and lateral directions will additionally be addressed. Special considerations for quality assurance will also be discussed such as: the stability of spot size, stability of scanning magnet operation; reproducibility of range modulation; and reproducibility of range shift at off-axis positions.

Learning Objectives:

1. Differentiate the uniform scanning and energy stacking technique from other beam delivery techniques.
2. Become familiar with the advantages, disadvantages, potential hazards, and hazard mitigations associated with the technique.
3. Become familiar with methods required to implement the technique including optimization and quality assurance.